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Molnar

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(54) **WHEELCHAIR SUSPENSION**

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This patent is subject to a terminal disclaimer.

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(58) **Field of Classification Search**

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See application file for complete search history.

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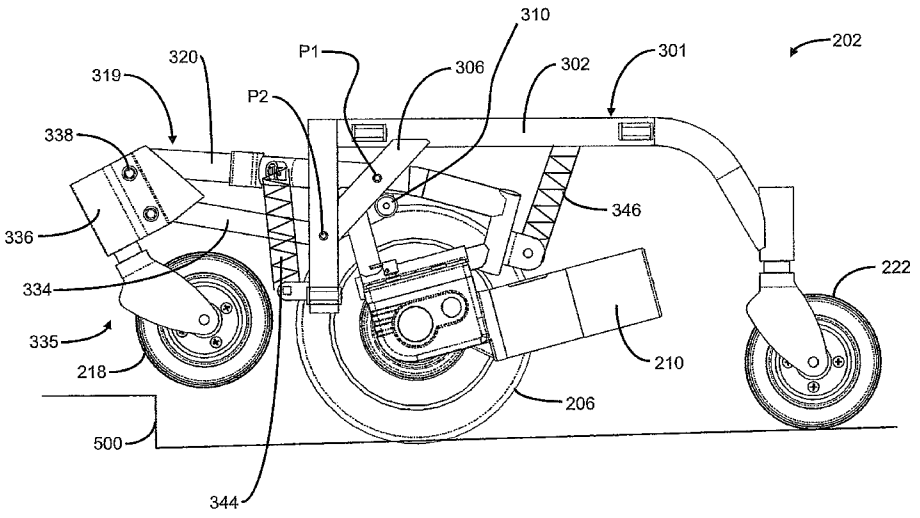
(57) **ABSTRACT**

A wheelchair includes a frame, a rear caster coupled to the frame, a drive wheel coupled to the frame, a front caster, and a pivoting assembly. The pivoting assembly couples the front caster to the frame such that upward movement of the front caster relative to the frame causes the front caster to move toward the drive wheel.

20 Claims, 6 Drawing Sheets



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Response in U.S. Appl. No. 13/566,473 dated Apr. 8, 2013.
Response to Office Action in U.S. Appl. No. 13/568,623 dated Jun. 19, 2013.
Notice of Allowance in U.S. Appl. No. 13/568,623 dated Oct. 9, 2013.
Notice of Allowance U.S. Appl. No. 13/568,623 dated Apr. 2, 2014.
Restriction Requirement in U.S. Appl. No. 12/900,548 dated Jun. 28, 2013.
Response to Restriction Requirement in U.S. Appl. No. 12/900,548 dated Jul. 29, 2013.
Office Action in U.S. Appl. No. 12/900,548 dated Sep. 9, 2013.
Response to Office Action in U.S. Appl. No. 12/900,548 dated Jan. 28, 2014.
Office Action in U.S. Appl. No. 12/900,548 dated Jun. 2, 2014.

* cited by examiner

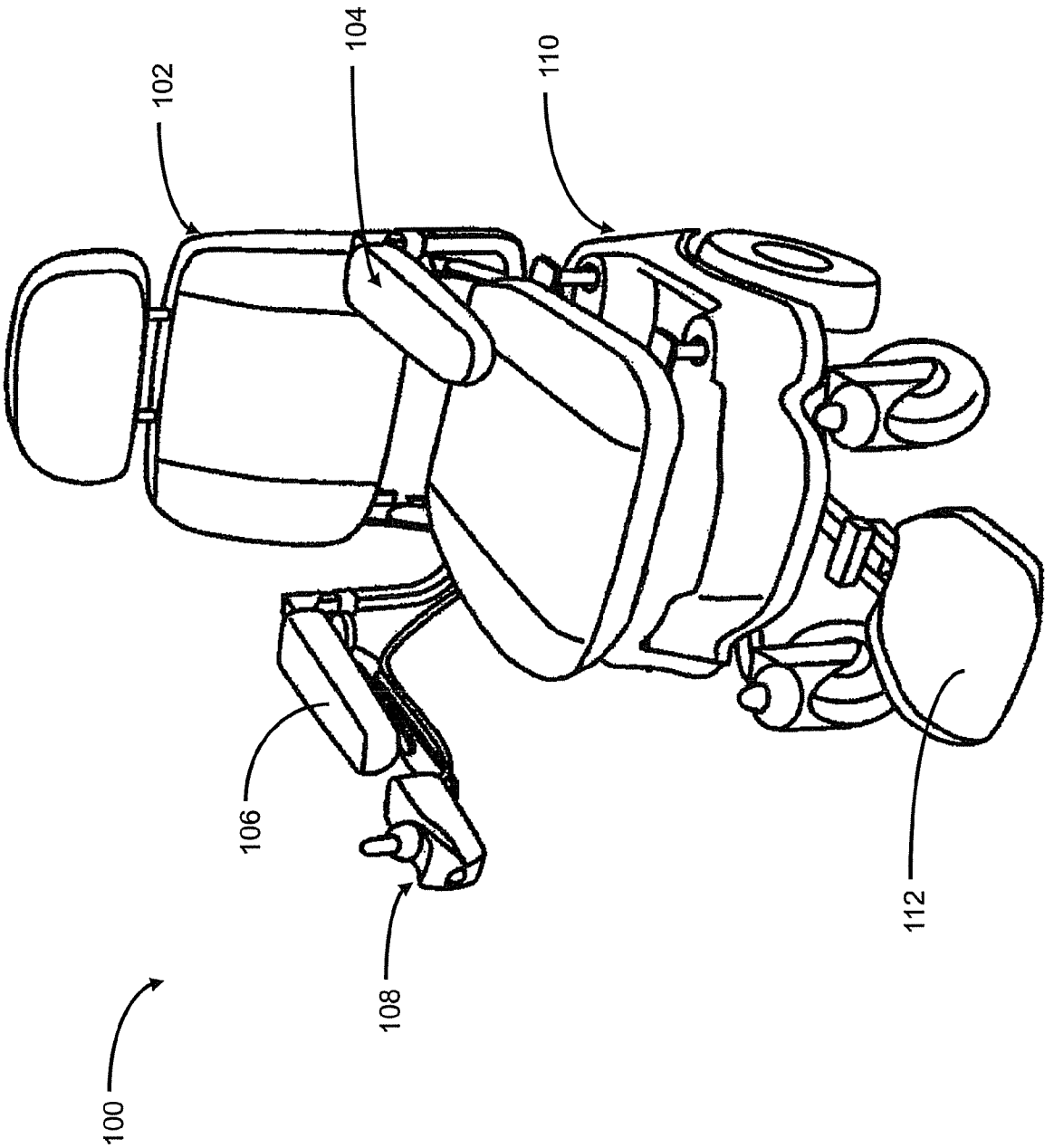
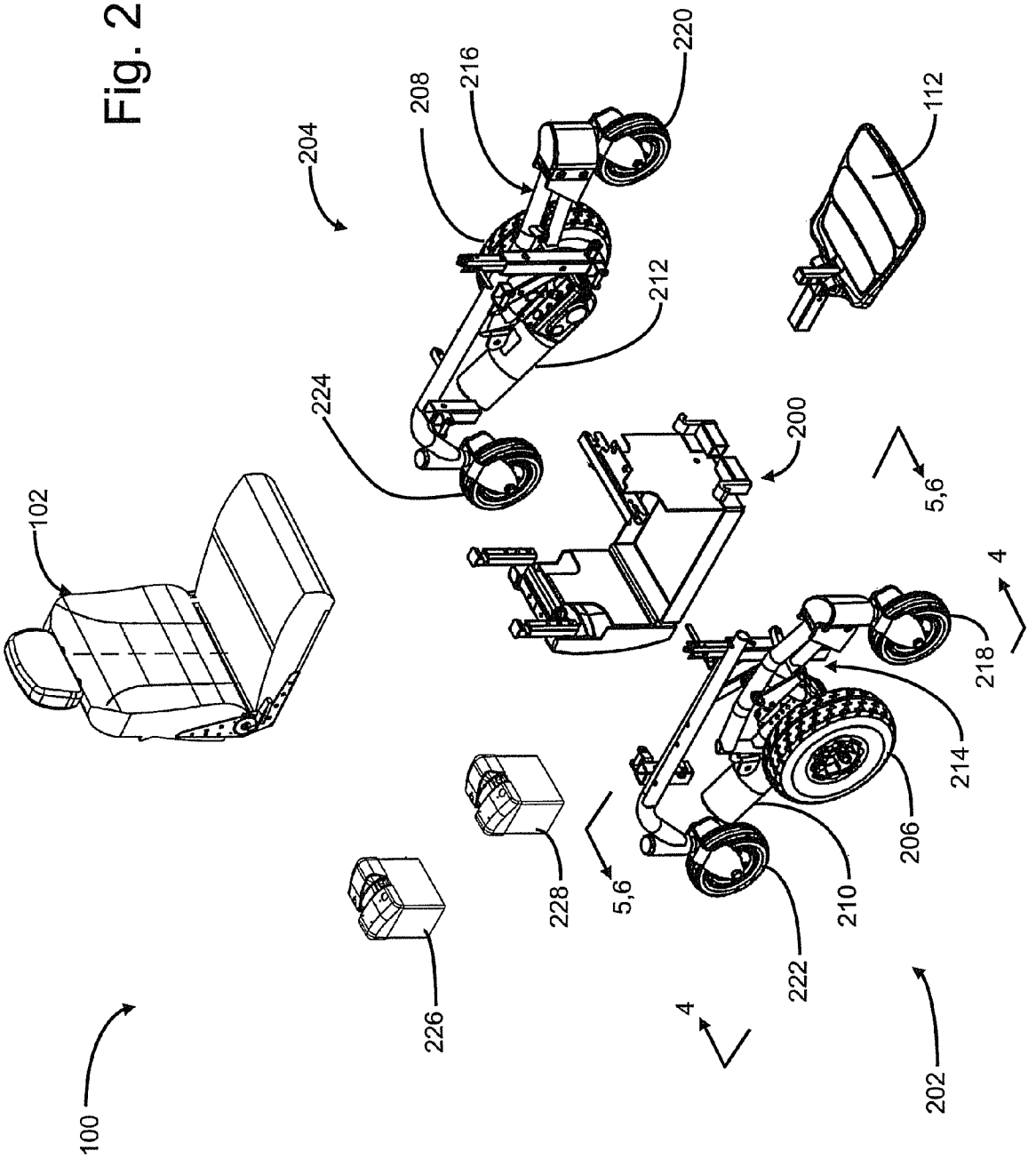


Fig. 1

Fig. 2


100
102
112
200
202
204
206
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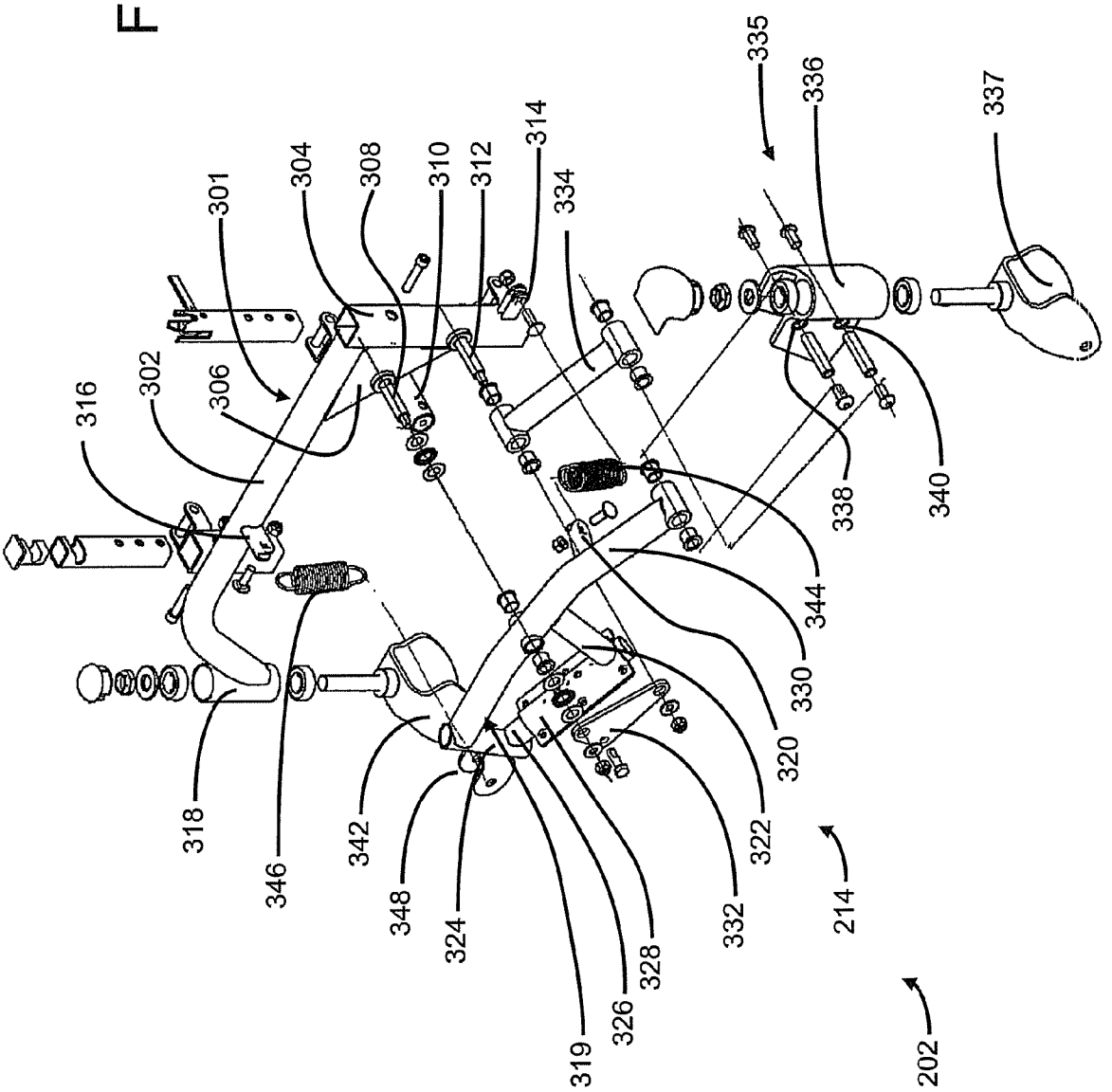
212
214
216
218
220
222
224
226
228
4
4
5,6
5,6

Fig. 3


301
302
304
306
308
310
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316
318
319
320
322
324
326
328
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332
334
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336
337
338
340
342
344
346
348
214
202

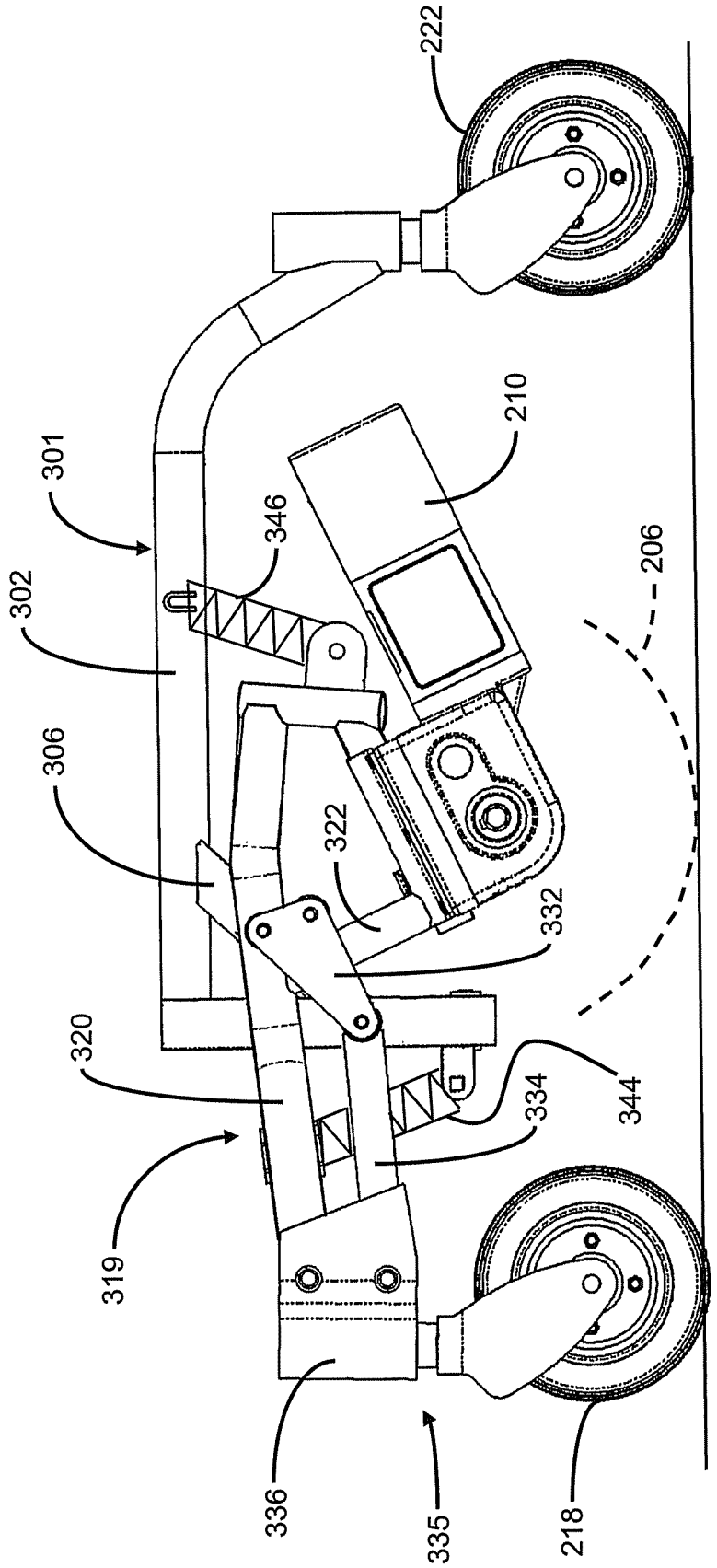


Fig. 4

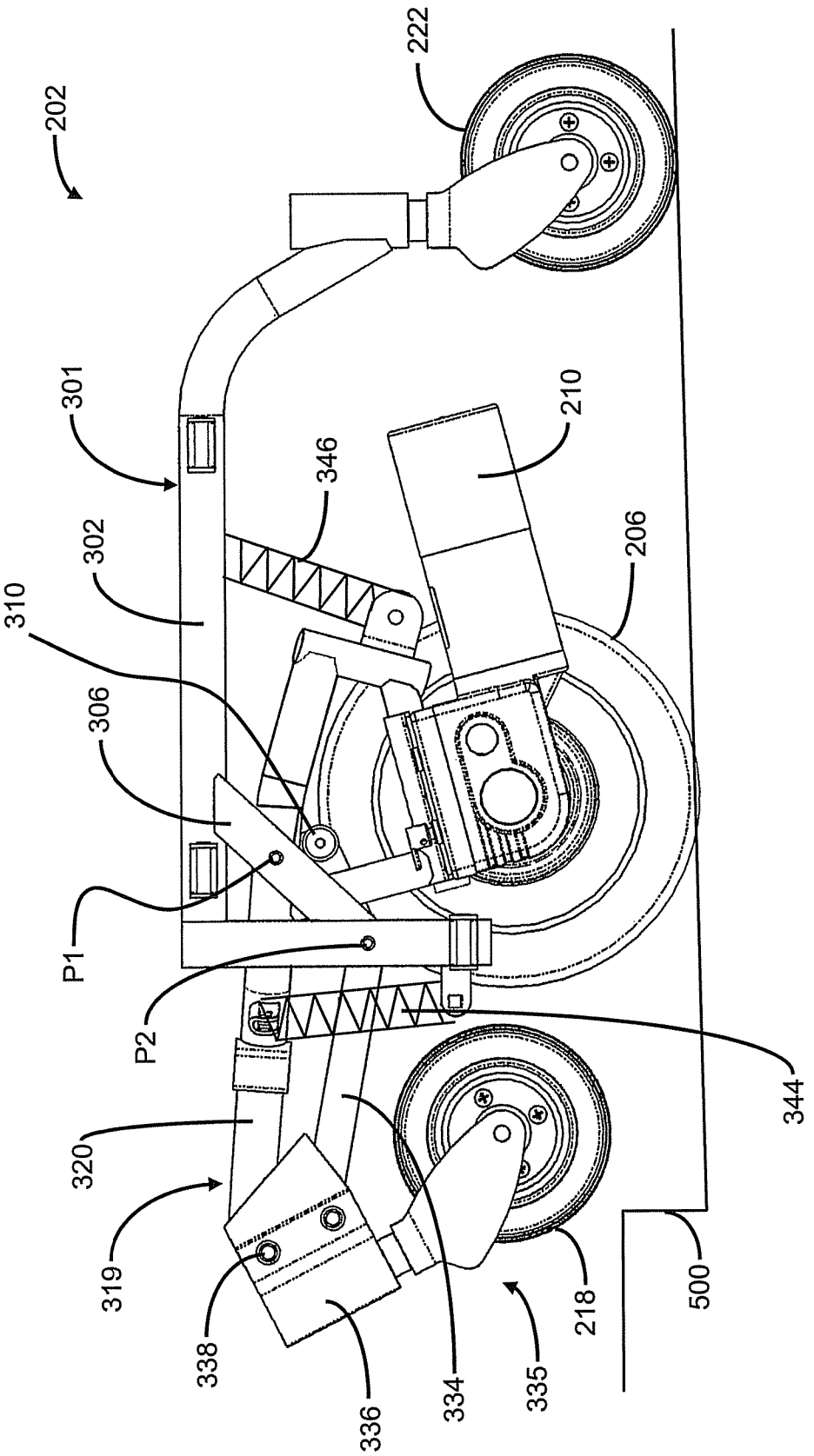
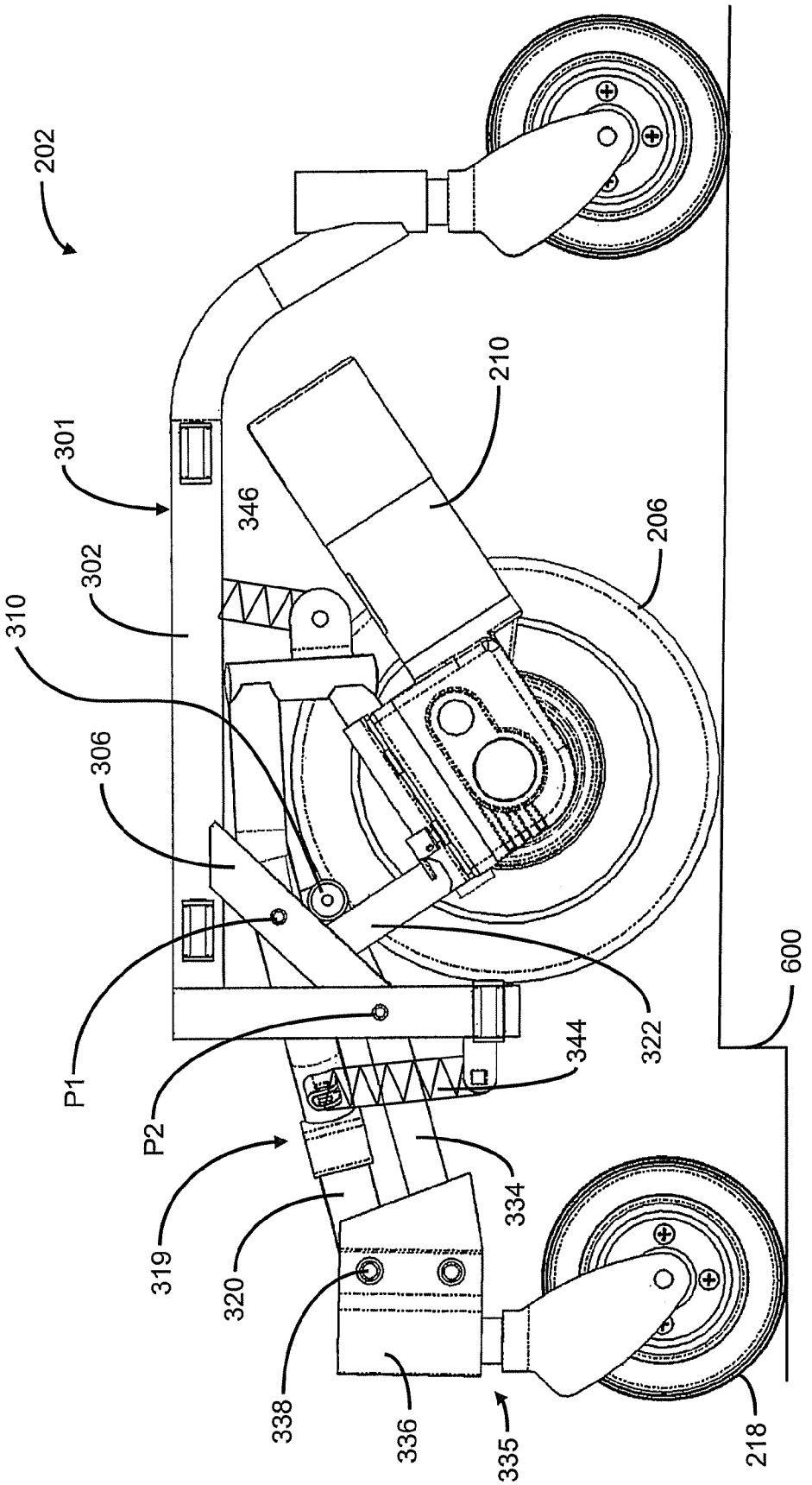

202
222
301
210
346
302
206
310
306
P1
P2
344
320
319
338
336
334
335
218
500

Fig. 5


202
301
302
310
306
346
210
206
322
600
344
P1
P2
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336
335
218

Fig. 6

WHEELCHAIR SUSPENSION

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 12/330,554, filed Dec. 9, 2008, now U.S. Pat. No. 8,172,015, issued May 8, 2012, titled "Wheelchair Suspension", which is a continuation of U.S. patent application Ser. No. 11/429,687, filed May 8, 2006, now U.S. Pat. No. 7,472,767, issued Jan. 6, 2009, which is a continuation of U.S. patent application Ser. No. 10/762,977, filed Jan. 22, 2004, now U.S. Pat. No. 7,055,634, issued Jun. 6, 2006, which is a continuation of U.S. patent application Ser. No. 09/974,348, filed Oct. 10, 2001, now U.S. Pat. No. 7,040,429, issued May 9, 2006, the disclosures of which are fully incorporated by reference herein in their entirety.

FIELD OF THE INVENTION

The invention relates generally to conveyances and, more particularly, to wheelchair suspensions.

BACKGROUND OF THE INVENTION

Wheelchairs are an important means of transportation for a significant portion of society. Whether manual or powered, wheelchairs provide an important degree of independence for those they assist. However, this degree of independence can be limited if the wheelchair is required to traverse obstacles such as, for example, curbs that are commonly present at sidewalks, driveways, and other paved surface interfaces.

In this regard, most wheelchairs have front and rear casters to stabilize the chair from tipping forward or backward and to ensure that the drive wheels are always in contact with the ground. One such wheelchair is disclosed in U.S. Pat. No. 5,435,404 to Garin. On such wheelchairs, the caster wheels are typically much smaller than the driving wheels and located both forward and rear of the drive wheels. Though this configuration provided the wheelchair with greater stability, it made it difficult for such wheelchairs to climb over obstacles such as, for example, curbs or the like, because the front casters could not be driven over the obstacle due to their small size and constant contact with the ground.

U.S. Pat. No. 5,964,473 to Degonda et al. describes a wheelchair having front and rear casters similar to Garin and a pair of additional forward lift wheels. The lift wheels are positioned off the ground and slightly forward of the front caster. Configured as such, the lift wheels first engage a curb and cause the wheelchair to tip backwards. As the wheelchair tips backwards, the front caster raises off the ground to a height so that it either clears the curb or can be driven over the curb.

U.S. Pat. No. 6,196,343 to Strautnieks also describes a wheelchair having front and rear casters. The front casters are each connected to a pivot arm that is pivotally attached to the sides of the wheelchair frame. Springs bias each pivot arm to limit the vertical movement thereof. So constructed, each front caster can undergo vertical movement when running over an obstacle.

SUMMARY OF THE INVENTION

The present invention relates to a wheelchair. The wheelchair includes a frame, a rear caster coupled to the frame, a drive wheel coupled to the frame, a front caster, and a pivoting assembly. The pivoting assembly couples the front caster to the frame such that upward movement of the front caster relative to the frame causes the front caster to move toward the drive wheel.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings which are incorporated in and constitute a part of the specification, embodiments of the invention are illustrated, which, together with a general description of the invention given above, and the detailed description given below, serve to example the principles of this invention.

FIG. **1** is a perspective view of a wheelchair incorporating the suspension of the present invention.

FIG. **2** is an exploded perspective view of certain components of the wheelchair of FIG. **1**.

FIG. **3** is an exploded detail view of certain components of a side frame assembly of the present invention.

FIG. **4** is a side elevational view of the side frame assembly under static conditions.

FIG. **5** is a side elevational view of the side frame assembly traversing an obstacle by ascending an obstacle.

FIG. **6** is a side elevational view of the side frame assembly traversing an obstacle by descending the obstacle.

DETAILED DESCRIPTION OF ILLUSTRATED EMBODIMENT

The present invention provides a wheelchair and suspension for traversing obstacles and rough terrain. The present invention facilitates the traversing of obstacles and rough terrain by allowing for the vertical and lateral movement of one or more front caster assemblies coupled to the wheelchair.

Referring now to FIG. **1**, a perspective view of a wheelchair **100** of the present invention is shown. Wheelchair **100** is preferably a mid-wheel drive or rear-wheel drive wheelchair. As shown, wheelchair **100** has a chair **102** having arm supports **104** and **106**. A control device such as, for example, a joystick controller **108** is attached to the chair **102** for controlling any power-related aspects of wheelchair **100**. Wheelchair **100** further has removable decorative shrouds **110** covering the wheelchair's suspension, drive, and control systems. Projecting forward from the shrouds **110** is footrest **112** for supporting the feet of the wheelchair's user.

Illustrated in FIG. **2** is an exploded perspective view of certain components of wheelchair **100**. The suspension system has a sub-frame **200** for accommodating, among other things, removable batteries **226** and **228**. Removably attached to sub-frame **200** are first and second side frame assemblies **202** and **204**. Side frame assemblies **202** and **204** are removably attached to sub-frame **202** via interfaces preferably in the form of spring loaded hooks and latches. The spring loaded hooks preferably reside on sub-frame **200** with the corresponding latches residing on side-frame assemblies **202** and **204**. In this manner, an individual can manually without the use of tools take apart wheelchair **100** for easy transportation in, for example, the trunk of a car or other large vehicle.

Each side frame assembly has at least one drive assembly having a motor drive **210** and **212** and a drive wheel **206** and **208**. Each motor drive **210** and **212** preferably has either a motor/gear box combination or a brushless, gearless motor. Each side frame assembly further has at least one front caster assembly **218** and **220** coupled thereto via pivoting assemblies **214** and **216**. At least one rear caster assembly **222** and **224** are also provided for each side frame assembly. Each of the side frame assemblies are identical in construction and,

hence, the present discussion will focus on describing side frame assembly **202** with the understanding that such discussion is equally applicable to side frame assembly **204**.

Referring now to FIG. **3**, an exploded detailed perspective of certain components of side frame simply **202** is shown. In this regard, side frame assembly **202** has a side frame member **301** having sub-members **302**, **304**, **306**, and **318**. These side frame sub-members are preferably tubular (i.e., circular, oval, or rectangular in cross-section) and formed and welded together has shown. Pivoting assembly **214** has a first pivoting linkage **319** defined by sub-linkages **320**, **322**, **324**, and **326**. These sub-linkages are also preferably tubular in configuration, as described above, and formed and welded together as shown. Sub-linkage **326** has a motor drive assembly mounting bracket **328** attached thereto. A second pivoting linkage **334** is also provided. As shown in FIG. **3**, the overall length of the first pivoting linkage **319** is greater than the overall length of the second pivoting linkage **334**. As will be presently described, this configuration facilitates, for example, the dual functions of lifting and retracting the front caster assembly **335** away from the obstacle to be traversed and inward toward the wheelchair.

The first pivoting linkage **319** is pivotally coupled to side frame member **301** via tubular stud or extension **308**. The second pivoting linkage **334** is pivotally coupled to side through member **301** via tubular stud or extension **312**. A compression plate **332** is provided for additional stability and is coupled to side frame member **301** via tubular studs or extensions **308** and **312** and pivot stop member **310**.

Resilient extension springs **344** and **346** are provided between side frame member **301** and first pivoting linkage **319**. In this regard, spring **344** has a first connection to frame member **301** via bracket **314** and a second connection to first pivoting linkage **319** via bracket **330**. Spring **346** has a first connection to frame member **301** via bracket **316** and a second connection to first pivoting linkage **319** via bracket **348**. As will be described in more detail, extension springs **344** and **346** are connected to first pivoting linkage **319** on either side of the linkages pivotal connection to side frame member **301** and provide a unidirectional bias force around the first pivoting linkage **319** pivotal coupling to side frame member **301**. Alternatively, resilient elastomeric members can be integrated into the pivotal coupling between first pivoting linkage **319** and side frame member **301**. Similarly, resilient elastomeric members can be integrated into the pivotal coupling between second pivoting linkage **334** and side frame member **301**. Such resilient elastomeric members can be "Rosta"-type bearings or other similar structures.

A front caster assembly **335** is pivotally coupled to each of the first and second pivoting linkages **319** and **334**. In this regard, front caster assembly **335** has an integral head tube/bracket **336** for receiving a caster fork **337** and making the aforementioned pivotal couplings to linkages **319** and **334**. These pivotal couplings to linkages **319** and **334** are facilitated by first and second holes **338** and **340** in head tube/bracket **336** and corresponding tubular formations in first and second pivoting linkages **319** and **334**. A rear caster is attached to side frame assembly **301** via rear caster fork **342**, which is received in sub-frame member **318**.

Configured as such, first and second pivoting linkages **319** and **334** pivot with respect to side frame member **301**. Moreover, front caster assembly **335** undergoes spatial displacement with the pivotal movement of first and second pivoting linkages **319** and **334**. The rear caster wheel and fork **342** are generally not affected by the pivotal movement of first and second pivoting linkages **319** and **334**.

Referring now to FIG. **4**, an outer side elevational view of side frame assembly **202** is shown under static conditions (i.e., the wheelchair is standing still or neither accelerating or decelerating). Drive wheel **206** is only partially shown so to not obscure the relevant components of side frame assembly **202**. In this state, all wheels including the drive wheels and front and rear caster wheels are in contact and maintain contact with the ground or other riding surface.

Referring now to FIG. **5**, an inner side elevational view of side frame assembly **202** is shown as the wheelchair traverses an elevated obstacle. The component displacement shown in FIG. **5** normally occurs when the wheelchair is quickly accelerated forward to traverse an obstacle such as curb **500**. For purposes of the present discussion, the pivotal coupling between first pivoting linkage **319** and side frame member **301** is designated by pivot P**1**. Similarly, the pivotal coupling between the second pivoting linkage **334** and side frame member **301** is designated by pivot P**2**. In relationship to each other, it can be seen that pivot P**2** is below and laterally offset from pivot P**1** in a direction toward the front caster. In other words, pivot P**2** is laterally closer to front caster assembly **335** than is pivot P**1**. In combination with the respective overall lengths of first and second pivoting linkages **319** and **334**, this configuration provides the dual functions of lifting and retracting the front caster assembly **335** away from the obstacle to be traversed and inward toward the wheelchair.

In this regard, when the wheelchair is accelerated forward by a high rate, the resulting moment arm generated by the drive wheel **206** will exceed the resultant moment arm generated by springs **344** and **346**. This causes first pivoting linkage **319** to pivot or rotate in a clockwise direction about pivot P**1** thereby raising front caster assembly **335**. This motion also causes second pivoting linkage **334** to undergo pivotal motion. The resulting effect of second pivoting linkage **334** motion is to cause front caster assembly **335** to pivot about its pivotal coupling **338** to first pivoting linkage **319**. This pivotal movement causes front caster assembly **335** to be drawn inward toward the wheelchair itself and away from the obstacle **500** being traversed. The maximum amount of pivotal movement is limited by stop **310**, which physically engages side frame member **301** sub-linkage **320**. The same effect described above is achieved should side frame assembly **202** be driven directly over obstacle **500**. Once the resultant movement arm generated by drive wheel **206** is less than the resultant movement arm generated by springs **344** and **346** with respect to pivot P**1** front caster assembly **335** is lowered.

Referring now to FIG. **6**, an inner side elevational view of side frame assembly **202** is shown as the wheelchair traverses descends an obstacle **600**. In this regard, the resultant moment arm generated by springs **344** and **346** is greater than any other moment arm around pivot P**1**. This causes first pivoting linkage **319** to rotate counter-clockwise and to lower the front caster assembly **335** on the lower supporting or riding surface. In this regard, the respective position of pivot P**2** and the overall length of second pivoting linkage **334** compared to the position of pivot P**1** and the overall length of first pivoting linkage **319** provide for front caster assembly **335** to descend to the lower supporting surface. Concurrently therewith, the pivotal motion of second pivoting linkage **334** causes front caster assembly **335** to pivot about its pivotal coupling **338** to first pivoting linkage **319**. This motion causes front caster assembly **335** to extend forward. The combined effect of lowering and extending front caster assembly **335** provide the wheelchair with greater stability when descending a obstacle because the wheelchair is sooner and longer in contact with the differing elevations that represent the obstacle. The maxi-

mum pivotal movement is once again limited by stop **310**, which physically engages side frame member **301** sub-linkage **322** in this scenario.

Hence, the present invention facilitates the traversing of obstacles and rough terrain by allowing for the vertical and lateral movement of one or more front caster assemblies.

While the present invention has been illustrated by the description of embodiments thereof, and while the embodiments have been described in considerable detail, it is not the intention of the applicant to restrict or in any way limit the scope of the appended claims to such detail. Additional advantages and modifications will readily appear to those skilled in the art. For example, a plurality of casters can be used instead of one caster, the casters can be coupled to the pivot arms via shock absorbing fork assemblies, and the specific locations of the pivotal couplings can be modified so long as the above-described overall relationships are maintained. Therefore, the invention, in its broader aspects, is not limited to the specific details, the representative apparatus, and illustrative examples shown and described. Accordingly, departures can be made from such details without departing from the spirit or scope of the applicant's general inventive concept.

The invention claimed is:

1. A wheelchair suspension comprising:
a frame;
at least one rear caster coupled to the frame;
a drive assembly coupled to the frame;
a pivoting assembly mounting a front caster to the frame, the pivoting assembly comprising:
a front caster assembly having a head tube rotatably receiving a caster fork that rotatably supports a caster wheel;
an upper link pivotally mounted to the front caster assembly at a first upper pivot axis and to the frame at a second upper pivot axis;
a lower link pivotally mounted to the front caster assembly at a first lower pivot axis and to the frame at a second lower pivot axis;
wherein the distance between the first upper pivot axis and the second upper pivot axis is different than the distance between the first lower pivot axis and the second lower pivot axis;
wherein the second lower pivot axis and the second upper pivot axis are substantially offset on the frame such that when the wheelchair suspension is on a level support surface a horizontal distance between the second lower pivot axis and the second upper pivot axis is greater than one-half a vertical distance between the second lower pivot axis and the second upper pivot axis.

2. The wheelchair suspension of claim **1** wherein the distance between the first upper pivot axis and the second upper pivot axis is greater than the distance between the first lower pivot axis and the second lower pivot axis.

3. The wheelchair suspension of claim **1** wherein the drive assembly is coupled to the pivoting assembly.

4. The wheelchair suspension of claim **1** wherein upward pivotal movement of the first and second pivot linkages causes the caster wheel to move toward the frame.

5. The wheelchair suspension of claim **1** further comprising a spring attached to each suspension assembly, such that the spring biases the front caster wheel into engagement with the ground.

6. A wheelchair suspension comprising:
a frame;
a rear caster coupled to the frame;
a drive wheel;
a front caster assembly having a head tube rotatably receiving a caster fork that rotatably supports a caster wheel;
a pivoting assembly that couples the front caster assembly to the frame at pivot axes such that upward movement of the front caster head tube relative to the frame causes the front caster wheel to move laterally toward the frame; and
wherein a drive axle of the drive wheel is below said pivot axes when the wheelchair is disposed on a level support surface.

7. The wheelchair suspension of claim **6** further comprising a spring coupled to the pivoting assembly such that the front caster wheel is biased into engagement with the ground.

8. The wheelchair suspension of claim **6** wherein the pivoting assembly comprises first and second pivot linkages pivotally coupled to the frame and the front caster assembly.

9. The wheelchair suspension of claim **6** wherein the drive wheel is coupled to the pivoting assembly.

10. A wheelchair suspension comprising:
a frame;
a rear caster coupled to the frame;
a drive wheel;
a front caster assembly having a head tube rotatably receiving a caster fork that rotatably supports a caster wheel; and
a pivoting means that couples the front caster assembly to the frame at a first pivot axis and a second pivot axis such that upward movement of the front caster assembly relative to the frame causes the front caster wheel to move toward the frame;
wherein the first pivot axis and the second pivot axis are substantially offset on the frame such that when the wheelchair suspension is on a level support surface a horizontal distance between the first pivot axis and the second pivot axis is greater than one-half a vertical distance between the first pivot axis and the second pivot axis.

11. The wheelchair suspension of claim **10** wherein the drive wheel is coupled to the pivoting assembly.

12. The wheelchair suspension of claim **10** further comprising a spring coupled to the pivoting assembly such that the front caster wheel is biased into engagement with the ground.

13. A wheelchair suspension comprising:
a frame;
at least one rear caster coupled to the frame;
a drive wheel coupled to the frame;
a pivoting assembly mounting a front caster to the frame, the pivoting assembly comprising:
a front caster assembly having a head tube rotatably receiving a caster fork that rotatably supports a caster wheel;
an upper linkage pivotally mounted to the front caster assembly and to the frame at respective upper pivot axes;
a lower linkage pivotally mounted to the front caster assembly and to the frame at respective lower pivot axes;
wherein the distance between the upper pivot axes is different than the distance between the lower pivot axes, such that upward movement of the front caster head tube relative to the frame causes the front caster wheel to move laterally toward the frame; and
wherein a drive axle of the drive wheel is below the lower pivot axes when the wheelchair is disposed on a level support surface.

14. The wheelchair suspension of claim 13 wherein the drive wheel is coupled to the pivoting assembly.

15. The wheelchair suspension of claim 13, wherein the distance between the upper pivot axes is greater than the distance between the lower pivot axes.

16. The wheelchair suspension of claim 13 further comprising a spring attached to the pivoting assembly such that the spring biases the front caster wheel into engagement with the ground.

17. A wheelchair comprising:

a frame member;

a drive assembly;

at least one rear caster coupled to the frame member;

at least one pivoting assembly having:

a first linkage pivotally coupled to the frame member at an upper pivot axis, wherein the upper pivot axis is disposed between a forward portion and a rearward portion of the first linkage; and

a second linkage pivotally coupled to the frame member; and

a third linkage pivotally coupled to the forward portion of the first linkage and to the second linkage, wherein a front caster is connected to the third linkage;

wherein the drive assembly is fixedly attached to the rearward portion of the first linkage; and

wherein upward pivotal movement of the first and second linkages causes the third linkage to undergo upward movement and lateral movement toward the drive assembly.

18. The wheelchair of claim 17 wherein the first linkage comprises a first length and the second linkage comprises a second length and wherein the first and second lengths are different.

19. A wheelchair suspension comprising:

a frame member having first and second sides;

a first drive assembly coupled to said first side;

a second drive assembly coupled to said second side;

a first pivoting assembly coupled to said first side at a first pair of pivot axes;

a second pivoting assembly coupled to said second side at a second pair of pivot axes;

a front caster assembly coupled to each of the first and second pivoting assemblies,

wherein each front caster assembly has a head tube rotatably receiving a caster fork that rotatably supports a caster wheel;

wherein each of the first and second pivoting assemblies are configured such that upward movement of the front caster assembly relative to the frame causes the front caster wheel to move laterally toward the drive assembly;

wherein a drive axle of a drive wheel of the first drive assembly is below said first pair of pivot axes when the wheelchair is disposed on a level support surface; and

wherein a drive axle of a drive wheel of the second drive assembly is below said second pair of pivot axes when the wheelchair is disposed on a level support surface.

20. The wheelchair suspension of claim 19 wherein the first and second drive assemblies are respectively coupled to the first and second pivoting assemblies.

* * * * *